REMARKS

Upon entry of the present amendment, claims 1-13 will remain pending in the above-identified application. Claim 9 has been amended. No new matter is being added by these amendments.

Before specifically discussing the rejection of the claims, it is believed that the following background information should be considered in order to shed a proper light on the development of the present invention and the advantageous features thereof. As discussed in the specification under "Prior Art", metal oxides have various functional properties. By virtue of such various functional properties, metal oxides have been used in various fields.

In general, the metal oxides used as components for an electric, an electronic or an optical device have a morphology containing a flat surface. For example, in a ceramic capacitor, a metal oxide having ferroelectric properties (such as barium titanate) is used in the form of a laminate wherein the metal oxide is sandwiched between two flat electrodes. Further, in a magnetic tape, a metal oxide (such as chromium oxide) is used in the form of a film formed on a polymer film. With respect to the various uses of the metal oxides, it should be noted that, in some uses, the performance of the component employing a metal oxide can be greatly improved by increasing the surface area of the metal oxide employed.

The development of a metal oxide structure having a large surface area while maintaining a small thickness will enable the production of an improved component for an electric, an electronic or an optical device. In addition, such a metal oxide structure is also expected to enable the development of new types of devices which can be used for producing new types of equipment.

As a method for producing a metal oxide structure having a large surface area, there is known a method in which whiskers comprised of metal oxide needles are formed. For example, Unexamined Japanese Patent Application Laid-Open Specification No. 50-6597 (which is cited in the office action) discloses a method for producing zinc oxide whiskers, in which a zinc alloy (comprising zinc and a metal having a boiling point higher than that of zinc) or a mixture of these two metals is heated under an oxygen-containing atmosphere in the presence of a substrate, to thereby form whiskers comprised of zinc oxide needles on the surface of the substrate. However, in this prior art technique, the formed zinc oxide whiskers are **cut off from the substrate** and provided for use **as reinforcements** for resins, ceramics and the like, and as semiconductors. In this prior art document, there is **no** disclosure suggesting that a structure comprising a substrate and whiskers formed thereon is used as a component for an electric or an electronic device or a component for an optical device.

In this situation, the present inventors have made extensive and intensive studies with a view toward developing a functional element for use in an electric, an electronic or an optical device, which comprises a substrate having a metal oxide structure formed on a surface thereof, wherein the metal oxide structure, on one hand, has a large surface area and, on the other hand, has a small thickness. As a result, the present inventors **have successfully developed a functional element**, which has been found to have excellent characteristics in that, although the metal oxide structure comprised of the needles has a very small thickness, the metal oxide structure has an extremely large surface area. Specifically, the functional element comprises a substrate having on an upper surface thereof a plurality of metal oxide needles extending upwardly of the upper surface of the substrate, with their respective central axes arranged substantially in parallel with each other, wherein the needles have a weighted average circle-based diameter of from 0.01 to 10,000 μm and a weighted average aspect ratio of 0.1 or more and wherein the needles are present at a density of from 0.01 to 10,000 needles per unit area having a size of 10 μm x 10 μm at the upper surface of the substrate. The present inventors have also found that the above-mentioned functional element can be advantageously applied to various fields including the fields of elements for use in electric or electronic devices. The present inventors have also developed a

method for effectively and efficiently producing the above-mentioned functional element. Based on the above findings, the present invention has been completed.

The functional element of the present invention can be advantageously applied to various fields including the fields of elements for use in electric or electronic devices, such as an electron emission element of energy saving type (i.e., an electron emission element having the capability of emitting electrons even under low voltages), a high-capacitance capacitor element, a high-density memory element and a high-sensitivity sensor element; and the fields of elements for use in optical devices, such as a laser emission element (particularly a laser emission element emitting a small wavelength laser, such as an ultraviolet laser) and a highly integrated optical switch element.

Claim 1 of the present application is essentially directed to a functional element for use in an electric, an electronic or an optical device, comprising a substrate having on an upper surface thereof a plurality of metal oxide needles extending upwardly of the upper surface of the substrate, with their respective central axes arranged substantially in parallel with each other, wherein the needles have a weighted average circle-based diameter of from 0.01 to 10,000 μm and a weighted average aspect ratio of 0.1 or more and wherein the needles are present at a density of from 0.01

to 10,000 needles per unit area having a size of 10 μm x 10 μm at the upper surface of the substrate.

Claim 9 of the present application is essentially directed to a method for producing a functional element for use in an electric, an electronic or an optical device, which comprises:

(a) gasifying at least one metal compound having volatilizability or sublimability and having the capability to react with at least one oxide-forming substance to form a metal oxide corresponding to the metal compound, to thereby obtain a metal compound gas, and

(b) applying the obtained metal compound gas onto a surface of a substrate which is placed in a reaction zone containing the oxide-forming substance and which is heated to a temperature higher than the temperature of the metal compound gas, to thereby contact the surface of the substrate with the metal compound gas in the presence of the oxide-forming substance for a period of time sufficient to grow a plurality of metal oxide needles on the surface of the substrate and form the functional element of claim 1.

In order to more clearly define the present invention, the Applicants have instantly amended claim 9 to state:

that, in step (a), the metal compound comprises a metal moiety and a non-metal moiety,

that, in step (a), the gasification of the metal compound is performed at a temperature of from 30 to 600 °C, and

that, in step (b), the heating temperature of the substrate (which is higher than the temperature of the metal compound gas) is not higher than 800 °C.

The amendment to state that the metal compound comprises a metal moiety and a non-metal moiety is supported by the entire disclosure of the present specification, especially by the fact that all examples of metal compounds described at page 34, line 25 to page 40, line 4 of the present specification are metal compounds each comprising a metal moiety and a non-metal moiety. Further, the expression "metal moiety" is found at, for example, page 25, line 23 of the present specification.

Support for the amendment to state that the gasification of the metal compound is performed at a temperature of from 30 to 600 °C is found at page 46, lines 17 and 18 of the present specification.

Support for the amendment to state that the heating temperature of the substrate is not higher than 800 °C is found at page 50, lines 1 to 3 of the present specification.

As also seen in the Proposed Amendment, the Applicants have also amended clerical errors found at page 1, line 11 and at page 14, line 9 of the present specification.

Turning now to the rejection of the claims, claims 1, 9 and 11-13 have been rejected under 35 U.S.C. 102(b) as being anticipated by JP'597 (JP 50-6597). Specifically, the Examiner states as follows:

> *"JP'597 teaches a method for producing zinc oxide whiskers on the surface of a substrate by heating a zinc alloy to gasify the alloy which will react with oxygen to form the oxide whiskers (translation, scope of claim for patent).*
>
> *JP'597 does not teach the orientation of the needles, the weighted average circle-based diameter, the weighted average aspect ratio or the density of the needles; however, <u>JP'597 teaches the same method of forming the needles which is claimed</u>, therefore the needles of JP'597 would have the same orientation, structure and density and thus would meet all of the claim limitations. Also, the figure of JP'597 shows the needles (8) as being substantially parallel and having an aspect ratio which appears to be greater than that claimed by Applicant. Furthermore, the claimed ranges for the average circle-based diameter, average aspect ratio and density are so broad that it would be reasonable to expect the whiskers of JP'597 to fall within the claimed ranges." (emphasis added)*

The JP'597 (Unexamined Japanese Patent Application Laid-Open Specification No. Sho 50-6597) discloses a method for producing zinc oxide whiskers, in which a zinc alloy of zinc and a metal having a boiling point higher than that of zinc or a mixture of these two metals is heated under an oxygen-containing atmosphere in the presence of a substrate, to thereby form zinc oxide whiskers on a surface of said substrate.

In order to clearly show the differences between the present invention and the technique of JP'597, the Applicants hereby submit ~~a verified new partial English translation~~ of JP'597, as Exhibit 2.

Firstly, the rejection of claim 9 is discussed. The Examiner appears to consider that the method of claim 9 of the present application (for producing the functional element of claim 1) is the same as the method of JP'597.

However, it should be noted that the method of the instantly amended claim 9 of the present application is clearly distinct from the method of JP'597. This point is explained below.

Firstly, it should be noted that, in the instantly amended claim 9, the metal compound employed comprises a metal moiety and a non-metal moiety.

On the other hand, the raw material employed in the method of JP'597 is "a zinc alloy of zinc and a metal having a boiling point higher than that of zinc or a mixture of these two metals". That is, the raw material employed in the method of JP'597 is a metal alloy or a mixture of two metals and hence does not contain a non-metal moiety.

Therefore, the raw material employed in the method of claim 9 of the present application is completely different from the raw material employed in the method of JP'597.

Secondly, it should be noted that, in step (a) of the method of the instantly amended claim 9, the gasification of the metal compound is performed at a temperature of from 30 to 600°C.

On the other hand, in the method of JP'597, the gasification of the raw material (a metal alloy or a mixture of two metals) is performed at a temperature of from 900 to 1,400°C. This is apparent from the fact that JP'597 states as follows:

> *"In the method of the present invention for producing whiskers, it is preferred that the heating temperature is from about 900°C to 1,400°C." (emphasis added) (see item (4) of Exhibit 2)*

Also, attention is drawn to the fact that in the Working Example of JP'597, the heating temperatures (gasification temperatures) which are used in run Nos. 1 to 3 are, respectively, 1,250°C, 1,200°C and 1,150°C (see the Table in item (6) of Exhibit 2).

Therefore, the gasification temperature (from 30 to 600°C) for the metal compound in the method of claim 9 of the present application is completely different from the gasification temperature (from 900 to 1,400°C) for the raw material in the method of JP'597.

In this connection, it should be noted that the reason why the gasification temperature for the raw material in the method of JP'597 is as high as from 900 to 1,400°C resides in that the raw material employed in the method of JP'597 is a zinc alloy or a

mixture of zinc and another metal, that is, the raw material does not contain a non-metal moiety. Zinc has a boiling point of 907°C. In the method of JP'597, the gasification of the raw material cannot be performed without using a gasification temperature (900 to 1,400°C) which is close to or higher than the boiling point of zinc (907°C). On the other hand, in the method of claim 9 of the present specification, since the metal compound employed comprises a metal moiety and a non-metal moiety, the gasification of the metal compound can be performed at a temperature as low as from 30 to 600°C.

Thirdly, it should be noted that, in step (b) of the method of the instantly amended claim 9, the heating temperature of the substrate is higher than the temperature of the metal compound gas and is not higher than 800°C.

On the other hand, in the method of JP'597, the heating temperature of the substrate is the same as the temperature of the gasified raw material (i.e., the gasification temperature for the raw material, which is in the range of from 900 to 1,400°C, as mentioned above). This is apparent from the fact that, in the Working Example of JP'597, the raw material (a zinc-copper alloy) is placed in a furnace having disposed therein a substrate, and the raw material is heated together with the substrate. Specifically, the procedure of the Working Example of JP'597 is as follows:

"*Example*

> *Zinc oxide whiskers were produced from a zinc-copper alloy, as follows.*
>
> *There were provided 3 rods of zinc-copper alloys wherein the 3 rods respectively had Zn/Cu weight ratios indicated in the Table below. The 3 rods were individually used. As shown in the figure below, each rod 1 was placed in a Tammann tube 3 having an inner diameter of about 60 mm, and the Tammann tube 3 containing the rod 1 was placed in a siliconite furnace 6 having, disposed on the inside surface thereof, a cylindrical substrate 7 made of mullite. The Tammann tube 3 containing the rod 1 was heated in the furnace 6, thereby growing zinc oxide whiskers 8 on the inside wall of the cylindrical substrate 7." (emphasis added) (see item (5) of Exhibit 2)*

Further, as already described above, in the method of JP'597, the heating temperature of the substrate (which is the same as the gasification temperature for the raw material) is from 900 to 1,400°C.

Therefore, the method of claim 9 of the present application is further distinct from the method of JP'597 not only in that the temperature of the substrate (not higher than 800°C) in the method of claim 9 of the present application is completely different from that (from 900 to 1,400°C) in the method of JP'597, but also in that the temperature relationship between the substrate and the metal compound gas in the method of claim 9 of the present application is completely different from the temperature relationship between the substrate and the gasified raw material in the method of JP'597.

As apparent from the above, the method of the instantly amended claim 9 of the present application is clearly distinct from the method of JP '597.

In this connection, attention should be drawn to the fact that, in the method of the present invention defined in claim 9 of the present application, the feature that the heating temperature of the substrate is higher than the temperature of the metal compound gas is critical for producing the functional element of claim 1 of the present application. In order to substantiate this contention of the Applicants, the Applicants have instantly performed an experiment to show that the feature (in claim 9 of the present application) that the heating temperature of the substrate is higher than the temperature of the metal compound gas is critical for producing the functional element of the present invention. The method and results of the experiment are as described in Exhibit 1 of the accompanying Mr. Ueda Declaration.

The procedure of the experiment of Exhibit 1 of the accompanying Mr. Ueda Declaration is a slight modification of the procedure of Example 1 of the present specification (Example 1 is described at page 79, line 14 to page 81, line 2 of the present specification). In Example 1 of the present specification, a functional element was produced under reaction conditions wherein the metal compound (zinc acetylacetonate) was gasified at 115°C

(i.e., the temperature of the metal compound gas was 115°C), and the substrate was heated to 550°C.

In the experiment of Exhibit 1, substantially the same procedure for producing a functional element as in Example 1 of the present specification was repeated except that the substrate was heated to 115°C, which is the same as the temperature of the metal compound gas (i.e., gasified zinc acetylacetonate). That is, in this experiment, the feature in claim 9 that the heating temperature of the substrate is higher than the temperature of the metal compound gas was <u>not</u> satisfied.

As a result, <u>no</u> metal oxide needles could not be grown on the surface of the substrate. Therefore, a functional element of the present invention could <u>not</u> be obtained.

From the above-mentioned results of Exhibit 1, it can be fairly concluded that the feature in claim 9 that the heating temperature of the substrate is higher than the temperature of the metal compound gas is critical for producing the functional element of the present invention.

In addition, as described below, the method of the instantly amended claim 9 of the present application is advantageous over the method of JP'597.

In the method of the instantly amended claim 9 of the present application, the gasification temperature for the metal compound is as low as from 30 to 600 °C and the heating temperature of the

substrate is as low as not higher than 800 °C, in contrast to the case of the method of JP'597 in which the heating temperature for both the raw material and the substrate is as high as from 900 to 1,400 °C. Therefore, the method of the instantly amended claim 9 of the present application is very advantageous in that the energy cost is remarkably low, as compared to that in the case of the method of JP'597, and that the heat resistance required for the production equipment is remarkably low (and hence the equipment cost is remarkably low), as compared to that in the case of the method of JP'597.

Therefore, it is apparent that the method of the instantly amended claim 9 of the present application has novelty and inventive step over the method of JP'597.

With respect to the zinc oxide needles of JP'597, the following should be noted.

As described at page 5, line 8 to page 6, line 2 and at page 33, line 13 to page 34, line 9 of the present specification and as also mentioned above, JP'597 is a technique in which the formed zinc oxide whiskers are cut off from the substrate and provided for use as reinforcements for resins, ceramics and the like, and as semiconductors. This point is apparent from the following description of JP'597:

> "*The present invention relates to a method for easily producing zinc oxide whiskers.*
> *Examples of uses of zinc oxide whiskers include*

> *reinforcements for various materials, and semiconductors."* (emphasis added) (see item (3) of Exhibit 2)

The above point (the fact that the whiskers of JP'597 are cut off from the substrate and provided for use as reinforcements or the like) is also apparent from the fact that, in the Working Example of JP'597, the whiskers obtained are measured with respect to tensile strength. Specifically, JP'597 has the following description:

> *"...when the whiskers ... were measured with respect to tensile strength, the whiskers were found to have a tensile strength as high as from about 50 to 200 kg/mm^2."* (emphasis added) (see item (7) of Exhibit 2)

As apparent from the above, JP'597 does not teach or suggest that a structure comprising a substrate and whiskers formed thereon is provided as a final product. In JP'597, the substrate is used only as a part of the equipment for producing the whiskers.

Therefore, JP'597 does not teach or suggest that a structure comprising a substrate and whiskers formed thereon is provided for use as a component for an electric or an electronic device or a component for an optical device.

Thus, JP'597 does not teach or suggest the functional element of the present invention for use in an electric, an electronic or an optical device, comprising a substrate having on an upper surface thereof a plurality of metal oxide needles extending upwardly of the upper surface of the substrate.

Further, attention is drawn to the fact that, as described above in detail, the method of claim 9 of the present application (for producing the functional element of claim 1) is clearly distinct from the method of JP'597. Therefore, there is <u>no</u> reason to consider that the whiskers obtained by the method of JP'597 satisfy the requirements of claim 1 of the present application.

From the above, it is apparent that the functional element of the present invention is has novelty and inventive step over the whiskers of JP'597.

It is believed that the patentability of claims 1 and 9 of the present application over JP'597 has been established.

Claims 1 and 6 have been rejected under 35 U.S.C. 102(b) as being anticipated by Hijikigawa et al (US 5,140,393). (Although the front page of U. S. Patent No. 5,140,393 indicates "Hijiki<u>**hi**</u>gawa et al.", the Certificate of Correction of this U. S. Patent states that the name of the primary inventor of this U. S. Patent should correctly read "Hijikigawa".) Particularly, the Examiner states as follows:

> *"Hijikihigawa teaches a sensor device which has a surface shaped to exhibit improved performance (col. 1, ln. 11-24). Hijikihigawa further teaches that by increasing the surface area of the sensor, it will exhibit enhanced detection sensitivity (col. 5, ln. 56-60). The increased surface area is provided by forming metal oxide projections such as tin oxide in various shapes such as trapezoidal, pyramidal, conical or semispherical (col. 4, ln. 53 - col. 5, ln. 14) and the projections are shown to be substantially oriented in a parallel direction (<u>Figure 1(a)</u>). Hijikihigawa also teaches that the projections*

can be suitably sized so as to have a specified shape and dimensions (col. 5, ln. 46-55).
Hijikihigawa is silent to the diameter and density of the projections; however it does teach that the distance d as shown in Figure 1(a) can be from 0.1 to several micrometers (col. 5, ln. 25-28). This is taken as a teaching that the projections have dimensions on the same scale and thus would meet the limitation of having diameters less than 10,000 μm and a whisker density within the claimed range.
Regarding the claimed aspect ratio of 0.1, the projections in Figure 1(a) appear to be just as high as they are wide and thus would meet the claim limitation." (emphasis added)

Hijikigawa et al. (U.S. Patent No. 5,140,393) disclose a sensor device comprising a substrate and a sensor formed thereon which is made of a metal, metallic oxide, semiconductor, dielectric or organic material, the sensor having projections or indentations formed on or in its surface with optional predetermined shape and dimensions (see the ABSTRACT of Hijikigawa et al).

Contrary to the Examiner's position, Hijikigawa et al. do not teach or suggest the functional element of the present invention. The reason is as follows.

The Examiner appears to consider that the sensor device shown in FIG. 1(a) of Hijikigawa et al. is similar to the functional element of the present invention. For easy reference, FIG. 1(a) of Hijikigawa et al. is produced below.

FIG. 1(a)

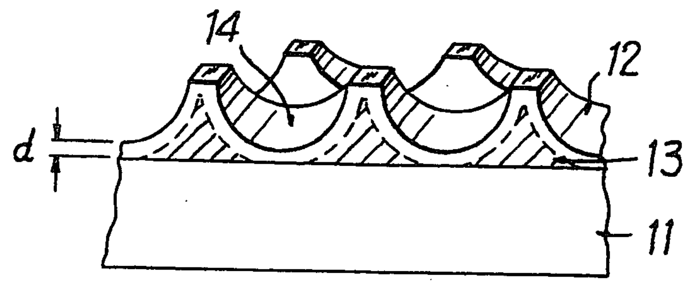


FIG. 1(b)

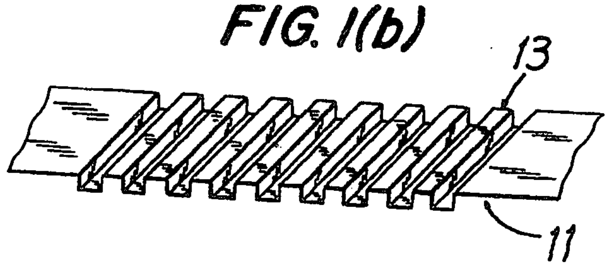


FIG. 1(c)

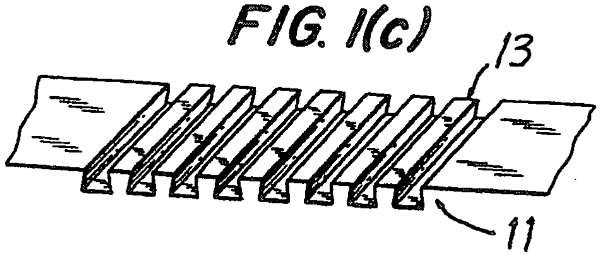


FIG. 1(d)

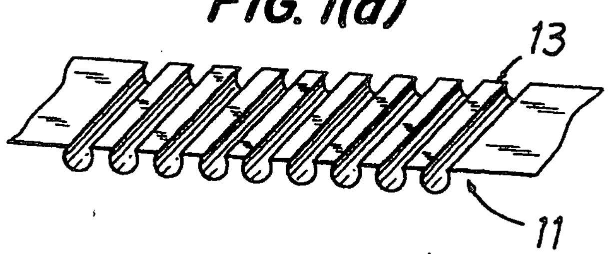


FIG. 1(e)

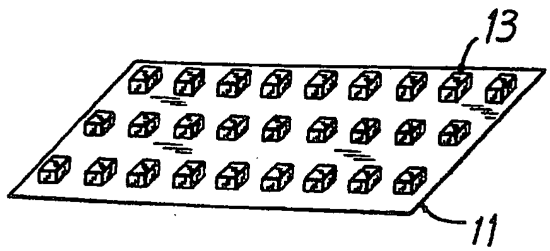


FIG. 1(f)

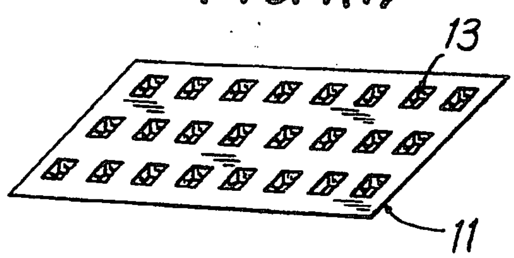
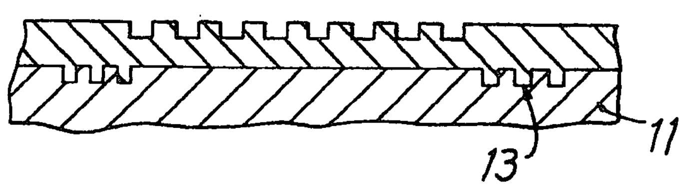


FIG. 1(g)



However, first, it should be noted that, as shown above, FIG. 1(a) of Hijikigawa et al. is only a diagram showing an example of an idea of design suitable for a sensor device. There is no evidence showing that a sensor device having a structure as shown in FIG. 1(a) of Hijikigawa et al. was actually produced.

It should also be noted that, in Hijikigawa et al., there is no evidence showing that any sensor device (especially one comprising a substrate having formed thereon metal oxide needles) was actually produced. Although Hijikigawa et al. have Examples 1 to 3, these Examples of Hijikigawa et al. provide no data showing that a senor device having any of the structural characteristics described in Hijikigawa et al. was actually produced and measured with respect to its properties (see column 6, line 4 to column 8, line 4 of Hijikigawa et al.). For easy reference, as a representative of Examples 1 to 3 of Hijikigawa et al., Example 1 of Hijikigawa et al. is reproduced below:

> "*EXAMPLE 1*
> *FIG. 2 is a diagram showing a semiconductor gas sensor device incorporating the above sensor.*
> *A tin oxide film, is formed on the upper surface of a ceramics substrate 21 by RF sputtering, and the surface of the tin oxide film is finely processed by photolithography and chemical etching. Platinum electrodes 23 are thereafter formed on the film at its opposites ends for measuring the electrical conductivity of the resulting sensor 22. A heater resistor 24 of platinum and electrodes 25 therefor are provided on the lower surface of the substrate for heating the sensor 22 during operation. Current is passed across the electrodes 25 to heat the resistor 24 and heat the sensor 22 to a suitable temperature. When the sensor 22 is*

> *placed in this state in a gas atmosphere, i.e. the object to be detected, the electrical resistance value of the sensor 22 varies with high sensitivity owing to the presence of the gas. The variation is detected via the opposed metal electrodes 23, whereby the presence of the gas is detectable."* *(see column 6, lines 4 to 23 of Hijikigawa et al.)*

Further, it should be noted that Hijikigawa et al. provide no photomicrograph showing the microscopic structure of any sensor device obtained in accordance with the technique of Hijikigawa et al.

Thus, Hijikigawa et al. provide no data obtained by experimentation. Hijikigawa et al. is not based on data obtained by experimentation.

Therefore, in Hijikigawa et al. there is no evidence showing that a structure falling in the definition of the functional element of the present invention can be produced by the technique of Hijikigawa et al.

In the functional element of the present invention defined in claim 1 of the present application, it is required that the metal oxide needles have a weighted average circle-based diameter of from 0.01 to 10,000 μm and a weighted average aspect ratio of 0.1 or more and that the metal oxide needles be present at a density of from 0.01 to 10,000 needles per unit area having a size of 10 μm x 10 μm at the upper surface of the substrate. In this connection, it should be noted that, as described in the present specification,

when any of the above-mentioned requirements of the weighted average circle-based diameter, weighted average aspect ratio and density is not satisfied, the desired high effect of the surface area increase aimed at by the present invention cannot be satisfactorily achieved (see page 17, lines 17 to 20; page 18, lines 2 to 4; and page 25, lines 14 to 16 of the present specification).

By contrast to Hijikigawa et al., the present invention is fully based on data obtained by experimentation. In Examples 1 to 6 of the present specification, functional elements of the present invention were actually produced and measured with respect to their properties (see page 79, line 14 to page 87, line 2 of the present specification). Examples 1 to 6 of the present specification describe in detail the production conditions and the properties of the functional elements produced. For easy reference, as a representative of Examples 1 to 6 of the present specification, Example 1 of the present specification is reproduced below:

> "*Example 1*
> *Using a system as shown in Fig. 1, a functional element was produced as follows. Zinc acetylacetonate ($Zn(C_5H_7O_2)_2$) was charged into a metal compound-heating vessel. The vessel was heated to gasify the zinc acetylacetonate under conditions wherein the internal temperature of the vessel was 115 °C. A single crystal plate (Al_2O_3) as a substrate, having a size of 10 mm x 5 mm, was placed on a heater located just under a blow-off slit of a nozzle so that the (0001) face of the Al_2O_3 single crystal faced the slit. The substrate was heated to 550 °C by means of the heater. Dry nitrogen gas was*

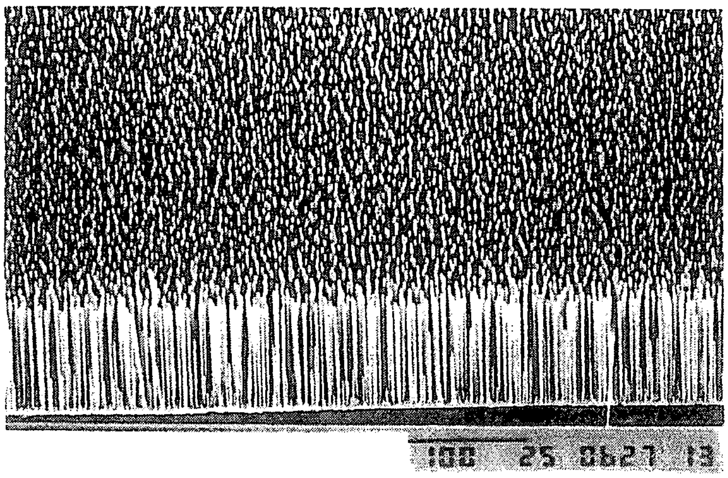
introduced into the metal compound-heating vessel at a flow rate of 1.2 dm^3/min. The gasified zinc acetylacetonate in the vessel, entrained by the nitrogen gas, was applied through the blow-off slit of the nozzle onto the surface of the Al_2O_3 single crystal plate under atmospheric pressure, thereby growing metal oxide (ZnO) needles on the surface of the substrate. 300 minutes after the start of the application, a functional element comprising the substrate and, grown on the surface thereof, a plurality of the metal oxide (ZnO) needles was obtained, which was then removed from the system.

Gold (an electroconductive substance) was vapor deposited on the functional element by sputtering at a thickness of 0.1 μm. Then, an observation of the functional element was conducted using a scanning electron microscope (hereinafter referred to simply as an "SEM").

<u>In order to elucidate the three-dimensional structure of the functional element, SEM photomicrographs showing perspective views of the obtained functional element were taken</u>, and shown in Figs. 2 (a) and 2 (b). The metal oxide (ZnO) needles had a weighted average circle-based diameter of 1.2 μm, a weighted average length of 100 μm and a density of 500 needles per unit area having a size of 10 μm x 10 μm. Further, the leaning angles of the crystal axes of the metal oxide needles were each 0.9 degree." (emphasis added) (see page 79, line 14 to page 81, line 2 of the present specification)

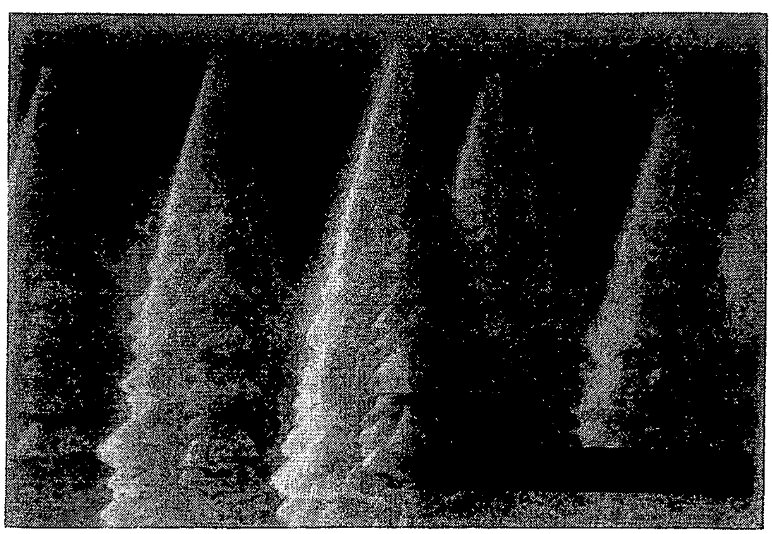
Further, it should be noted that Fig. 2 (a), Fig. 2 (b) and Figs. 3 to 7 of the present application show SEM photomicrographs of the functional elements produced in Examples 1 to 6 of the present specification (see, for example, the BRIEF DESCRIPTION OF THE DRAWINGS, specifically page 9, line 6 to page 10, line 1 of the present specification). For easy reference, Fig. 2 (a), Fig. 2 (b) and Figs. 3 to 7 of the present application are reproduced below:

F I G. 2 (a)



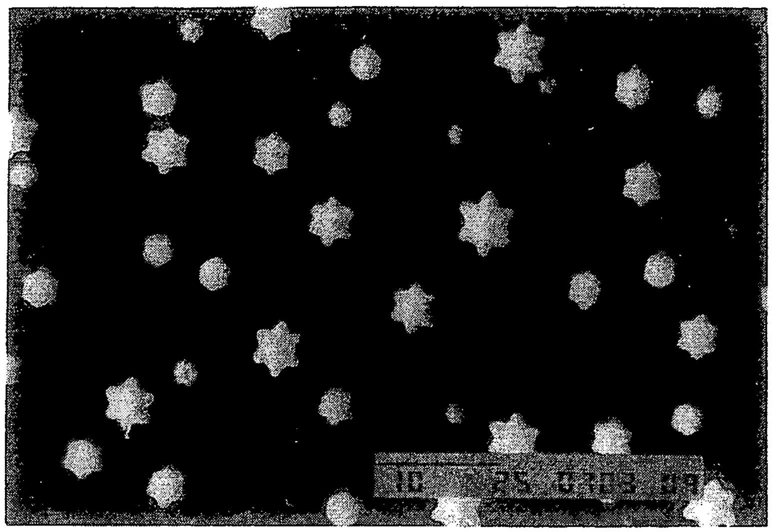
100 μm

F I G. 2 (b)



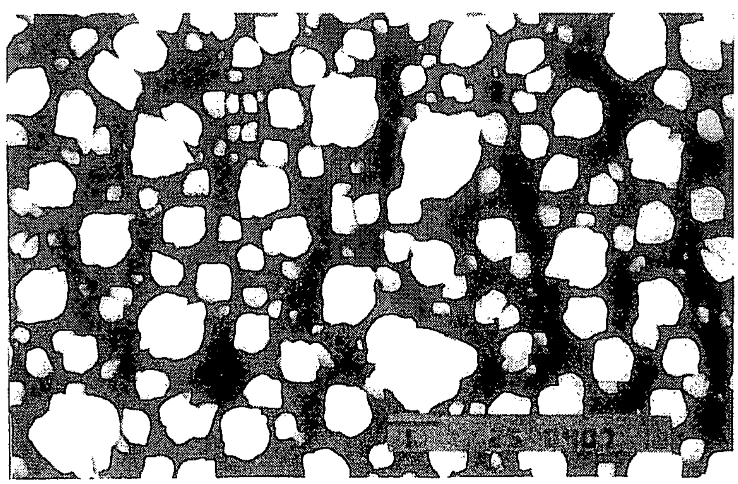
1 μm

FIG. 3



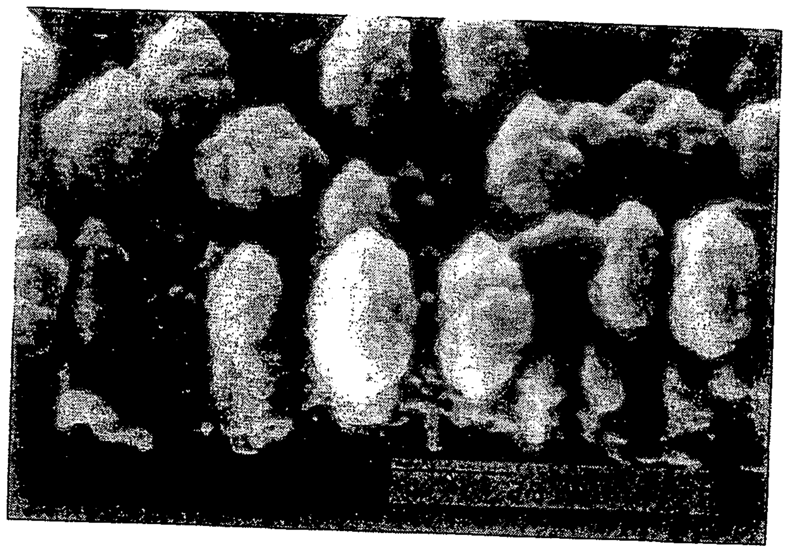
10 μm

FIG. 4



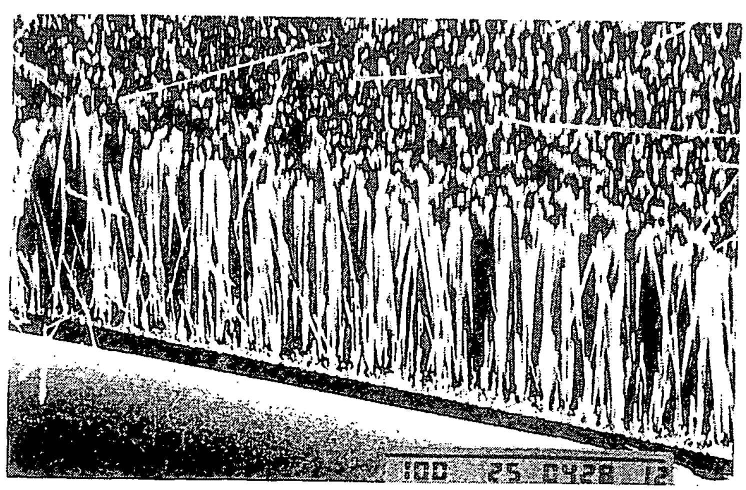
1 μm

FIG. 5



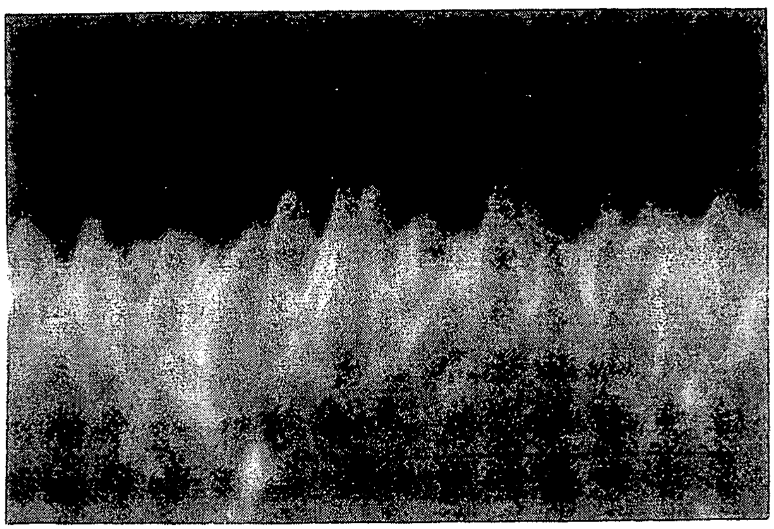
1 μm

FIG. 6



100 μm

FIG. 7



1 μm

In addition, in Example 7 of the present specification, a functional element of the present invention was used as an electron emission element and its performance was evaluated (see page 87, line 4 to page 90, line 4 of the present specification). Further, the performance of the functional element of the present invention was compared with that of a comparative element (a nickel plate) (Comparative Example). For easy reference, Example 7 and Comparative Example of the present specification are reproduced below:

> "*Example 7 and Comparative Example*
> *A functional element was produced in substantially the same manner as in Example 6. A circuit device (shown in Fig. 8) containing the functional element as an electron emission element was produced as follows.*
> *The functional element (10 mm x 5 mm), comprising an Al_2O_3 substrate (1) and ZnO needles (2), was fixed onto a silicon (Si) plate having a size of 15 mm x 15 mm. The silicon plate having the functional element fixed thereonto was placed in a sputtering apparatus (SPF-332, manufactured and sold by ANELVA Corporation, Japan). A nickel sputtering was conducted under a pressure of 0.1 torr in an argon atmosphere for an hour to thereby form a nickel layer (3) having a thickness of 8 μm on the surface of the functional element and on the surface of the exposed shoulder portion of the silicon plate having fixed thereonto the functional element. The functional element having the nickel layer on the surface thereof was used as an electron emission element as follows.*
> *The electron emission element (fixed onto the silicon plate), silicon plates (6) as spacers, an electroconductive paste (7) and a copper plate (8) were assembled as shown in Fig. 8 so that the nickel layer (3) formed on the surface of the functional element and the copper plate (8) were connected with each other through the electroconductive paste (7). The copper plate (8) was connected with an external electrode, which was earthed. On the other hand, there was provided a copper plate (4) having a lower surface thereof coated with an*

insulating film (5) which has a square-shaped opening having a size of 2 mm x 2 mm at the center of the film to thereby leave a non-coated portion in the lower surface of the copper plate (4). The copper plate (4) was connected with an external electrode, which in turn was connected with an anode. The copper plate (4) having the insulating film (5) coated on the lower surface thereof was fixed onto the upper surfaces of the silicon plates (6) placed on both sides of the functional element having the nickel layer (3) thereon so that the non-coated portion of the lower surface of the copper plate (4) faced the functional element having the nickel layer (3) thereon, wherein the distance between the non-coated portion of the lower surface of the copper plate (4) and the nickel layer (3) formed on the surface of the functional element became 0.5 mm. Thus, a circuit device was obtained having a vertical cross-sectional view shown in Fig. 8. This circuit device was provided for Example 7.

Another circuit device was produced in substantially the same manner as described above, except that a nickel plate having a size of 10 mm x 5 mm x 0.5 mm was used instead of the functional element having the nickel layer on the surface thereof. This circuit device was provided for Comparative Example.

The circuit device of Example 7 and the circuit device of Comparative Example were individually placed in a vacuum chamber. The internal pressure of the chamber was adjusted to 6 x 10^{-6} torr. The anode and the earth were connected with each other through a current-voltage meter and a high voltage power source so that the current-voltage meter was positioned on the side of the anode and the high voltage power source was positioned on the side of the earth. Then, the electron emission was conducted and the emission current was measured.

In the circuit device of Example 7, in which the functional element of the present invention was used as an electron emission element, the emission current was as high as 5 μA when a voltage of 5 kV was applied across the anode and the earth. By contrast, in the circuit device of Comparative Example, in which the above-mentioned nickel plate was used instead of the functional element of the present invention, the emission current was as low as 0.4 μA when a voltage of 5 kV was applied across the anode and the earth." (emphasis added) (see page 87, line 4 to page 90, line 4 of the present specification)

Thus, it is apparent that the present invention is fully based on data obtained by experimentation, completely differing from the case of Hijikigawa et al. that is not based on data obtained by experimentation.

In other words, the practicability of the present invention is fully substantiated by experimentation, in contrast to the case of Hijikigawa et al. that is not based on data obtained by experimentation.

Therefore, it is apparent that the technique of Hijikigawa et al. cannot be compared with the present invention.

Further, it should be noted that Hijikigawa et al. do not teach or suggest the method of claim 9 of the present application (for producing the functional element of claim 1). Therefore, there is no reason to consider that a sensor device obtained by the technique of Hijikigawa et al. satisfies the requirements of claim 1 of the present application.

From the above, it is apparent that Hijikigawa et al. do not teach or suggest the functional element of the present invention and that the functional element of the present invention has novelty and inventive step over the sensor device of Hijikigawa et al.

It is firmly believed that the patentability of claim 1 of the present application over Hijikigawa et al. has been established.

Claims 2 to 8 and 10 have been rejected under 35 U.S.C. 103(a) as being unpatentable over JP'597 (JP 50-6597).

Claims 2 to 8 depend from claim 1. Claim 10 depends from claim 9. As discussed above in detail, it is believed that the patentability of both claims 1 and 9 over JP'597 has been established.

Therefore, it is believed that the rejection of claims 2 to 8 and 10 has been removed.

Claims 1 to 5, 7 and 8 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Hijikigawa et al. (US 5,140,393).

As discussed above in detail, it is apparent that Hijikigawa et al. do not teach or suggest the functional element of the present invention and that the functional element of the present invention has novelty and inventive step over the sensor device of Hijikigawa et al.

Therefore, it is believed that the rejection of claims 1 to 5, 7 and 8 under 35 U.S.C. 103(a) has been removed.

Claims 9 to 13 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Hijikigawa et al (US 5,140,393) in view of JP'597 (JP 50-6597).

As discussed above in detail, the method of the instantly amended claim 9 of the present application has novelty and inventive step over the method of JP'597.

As also discussed above in detail, the functional element of the present invention has novelty and inventive step over the sensor device of Hijikigawa et al.

Therefore, it is apparent that the method of the instantly amended claim 9 of the present application cannot be taught or suggested by any combination of Hijikigawa et al. and JP'597.

From the foregoing, it is apparent that any of the cited references has no teaching or suggestion about the essential features of the present invention and effects thereof.

It is believed that the present application is now in condition for allowance.

Reconsideration and early favorable action on the claims are earnestly solicited.

CONCLUSION

Based on the amendments and remarks presented herein, the Examiner is respectfully requested to issue a Notice of Allowance clearly indicating that each of Applicants' pending claims are allowed and patentable under the provisions of Title 35 of the United States Code.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John W. Bailey (Reg. No. 32,881) at the

telephone number below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

Attached hereto is a marked-up version of the changes made to the application by this Amendment.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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By ______________________
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JWB/end
0216-0415P

Attachment: Version with Markings to Show Changes Made
37 CFR § 1.132 Declaration of Mr. Hidetoshi Saito
Exhibit 2

(Rev. 02/20/02)

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The paragraph beginning on page 1, line 7, has been amended as follows:

The present invention relates to a functional element for use in an electric, an electronic or an optical device. More particularly, the present invention is concerned with a functional element for use in an electric, an electronic or an optical device, comprising a substrate having on an upper surface thereof a plurality of metal oxide needles extending upwardly of the upper surface of the substrate, with their respective central axes arranged substantially in parallel with each other, wherein the metal oxide needles have a specific weighted average circle-based diameter and a specific weighted average aspect ratio, and wherein the metal oxide needles are present at a specific density at the upper surface of the substrate. The present invention is also concerned with a method for producing the above-mentioned functional element. The functional element of the present invention has an advantage in that, although the metal oxide structure therein comprised of the needles has a very large surface area, the metal oxide structure has a very small thickness. Therefore, the functional element of the present invention can be

very advantageously used as a component for an electric, an electronic or an optical device.

The paragraph beginning at page 14, line 8 has been amended as follows:

7. The functional element according to item 1 above, which is a laser emission element for use in an optical device.

IN THE CLAIMS:

The claims have been amended as follows:

9. (Amended) A method for producing a functional element for use in an electric, an electronic or an optical device, which comprises:

(a) gasifying, at a temperature of from 30 to 600 °C, at least one metal compound comprising a metal moiety and a non-metal moiety, said metal compound having volatilizability or sublimability and having the capability to react with at least one oxide-forming substance to form a metal oxide corresponding to said metal compound, to thereby obtain a metal compound gas,

and

(b) applying the obtained metal compound gas onto a surface of a substrate which is placed in a reaction zone containing said oxide-forming substance and which is heated to a temperature which

is higher than the temperature of said metal compound gas and which is not higher than 800 °C, to thereby contact the surface of said substrate with said metal compound gas in the presence of said oxide-forming substance for a period of time sufficient to grow a plurality of metal oxide needles on the surface of said substrate and form the functional element of claim 1.